Description

RECIPROCATING COMPRESSOR HAVING SUPPORTING UNIT ATTENUATING LATERAL DISPLACEMENT THEREOF

Technical Field

[1] The present invention relates to a reciprocating compressor having a supporting unit attenuating its lateral displacement, and more particularly, to a reciprocating compressing having a supporting unit attenuating its lateral displacement capable of minimizing lateral vibration of a compressor, which is generated in a direction that a reciprocating motor is operated in operation of the reciprocating compressor.

Background Art

[2] In general, a reciprocating compressor constitutes an air conditioning device, sucks a refrigerant gas thereinto and discharges the compressed refrigerant gas outside the compressor as a piston linearly reciprocates in a cylinder.

[3] As shown in Figure 1, a conventional reciprocating compressor includes a casing 10 forming an exterior, having a certain space therein and including a suction pipe (SP) through which a refrigerant gas is introduced and a discharge pipe (DP) through which the refrigerant gas compressed in the compressor is discharged outside; a compressor main body 70 positioned in the casing 10, for compressing the sucked refrigerant gas; and a supporting unit 60 having a plurality of coil springs elastically connecting the compressor main body 70 to one surface of the casing 10 so that the main body 70 is fixed to the casing 10.

[4] The main body 70 of the compressor includes a frame unit 20 elastically connected to the supporting unit 60 and forming the whole frame of the main body 70; a reciprocating motor 30 fixedly installed at the frame unit 20 and generating a linear reciprocating driving force; and a compressing unit 40 supported at the frame unit 20 and compressing the sucked refrigerant gas by a driving force of the reciprocating motor 30.

[5] The frame unit 20 includes a front frame 21 having one surface supported by the supporting unit 60 and fixing one surface of the reciprocating motor 30; a middle frame 22 fixed at the other surface of the reciprocating motor 30 fixed at the front frame 21; and a rear frame 23 having one surface elastically fixed by the supporting unit 60 and connected to the middle frame 22.

[6] The reciprocating motor 30 includes an outer stator 31 fixedly installed between

the front frame 21 and the middle frame 22 and having a winding coil 34 therein; an inner stator 32 facing the outer stator 31 at a certain interval and fixedly installed at one side of the front frame 21; and a rotor 33 linearly moving between the outer stator 31 and the inner stator 32.

[7] The compressing unit 40 includes a cylinder 41 inserted into the front frame 21 to be fixed thereto; a piston 42 having a path (F) for a refrigerant gas therein and having one end connected to the rotor 33 to thereby reciprocate in the cylinder 41; a suction valve 43 installed at a front end surface of the piston 42, for opening and closing the refrigerant gas path (F); and a discharge valve assembly 44 installed at one end surface of the cylinder 41, for controlling discharge of the compressed refrigerant gas. A compressing space (P) is formed between the suction valve 43 and the discharge valve assembly 44.

[8] Here, a front resonant spring 51 and a rear resonant spring 52 causing a resonant motion of the piston 42 are installed between one end of the piston 42 connected to the rotor 33 and one end of the front frame 21 and between the one end of the piston 42 and one end of the rear frame 23, respectively.

[9] A plurality of coil springs constituting the supporting unit 60 includes a front coil spring 61 connecting the front frame 21 to one surface of the casing 10; and a rear coil spring 62 connecting the rear frame 23 to one surface of the casing 10, so that the main body 70 is elastically fixed to the inside of the casing 10.

[10] As shown in Figures 1 and 2A, the plurality of coil springs 61 and 62 are formed by being spirally wound several times at regular intervals, having the same diameter. That is, the coil spring 61, 62 has an inner coil 58 wound plural times and end coils 59 formed at both ends of the inner coil 58.

[11] The inner coil 58 is wound at regular pitches (t), and each of the end coils 59 is tightly wound so that the coil spring 61, 62 can be fixed to one surface of the compressor main body 70-the front frame 21 and the rear frame 23- and one surface of the casing 10

[12] The conventional reciprocating compressor as described above is operated as follows.

[13] When a current is applied to a winding coil 34 of an outer stator 31 of a reciprocating motor 30, an induction magnetic field having a direction changed according to a direction of a current is formed at the outer stator 31, and an electromagnetic force having a direction changed according to a direction of the induction magnetic field is generated between the outer stator 31 and the inner stator 32 by the

interaction between the induction magnetic field and a magnetic filed of the inner stator 32. Here, a rotor 33 and a piston 42 are moved together in a direction of the electromagnetic force, and, simultaneously, the piston 42 generates a pressure difference in a compressing space (P) of the cylinder 41 while linearly reciprocating in the cylinder by front and rear resonant springs 51 and 52, thereby repeatedly performing a series of processes of sucking a refrigerant gas and compressing the sucked refrigerant gas until the pressure reaches a certain level and discharging the compressed refrigerant gas.

[14] When the compressor passes through the processes of sucking and discharging a refrigerant gas by an operation of the reciprocating motor, vibration is generated at the main body. Such vibration of the compressor main body is reduced by a supporting unit including a plurality of coil springs having regular pitches, and thus noise and vibration transmitted to the casing of the compressor is reduced, too.

[15] However, the conventional reciprocating compressor as above is mostly vibrated in a lateral direction by nature, that is, in a direction that the piston of the reciprocating motor moves. Nevertheless, the lateral stiffness of the coil spring is weak because an internal coil of each coil spring for supporting the main body of the reciprocating compressor is formed at regular pitches. For this reason, as shown in Figure 2B, a lateral displacement (L) of the compressor becomes great, and thus the compressor main body is excessively inclined, thereby making the vibration of the compressor severe.

Disclosure for invention

[16] Therefore, it is an object of the present invention to provide a reciprocating compressor having a supporting unit attenuating a lateral displacement capable of minimizing lateral vibration of a compressor, which is generated in a direction that a reciprocating motor is operated when the reciprocating compressor is in operation.

[17] To achieve the above object, there is provided a reciprocating compressor comprising: a casing including a suction pipe through which a fluid is introduced from the outside and a discharge pipe through which the fluid is discharged outside and forming a predetermined internal space; a compressor main body positioned in the casing, compressing the fluid introduced through the suction pipe by a linear reciprocating motion of a piston and discharging the compressed fluid through the discharge pipe; and a supporting unit including a plurality of coil springs connecting the compressor main body to the casing, wherein the plurality of coil springs include, respectively, end coils tightly wound to be fixed to one surface of the compressor main body and to one surface of the casing; and an inner coil positioned between the pair of

the end coils and having at least one part wound tightly.

Description of Drawings

[18] Figure 1 is a longitudinal sectional view of a conventional reciprocating compressor;

[19] Figure 2A is a side view showing a coil spring of a conventional reciprocating compressor;

[20] Figure 3A is a view showing a lateral displacement of a coil spring of a conventional reciprocating compressor;

[21] Figure 3 is a longitudinal sectional view showing one example of a reciprocating compressor in accordance with the present invention;

[22] Figure 4 is a partial longitudinal sectional view of a reciprocating compressor, for showing a coil spring in accordance with a first embodiment of the present invention;

[23] Figure 5A is a side view showing a coil spring in accordance with a first embodiment of the present invention;

[24] Figure 5B is a view showing a lateral displacement of a coil spring in accordance with a first embodiment of the present invention;

[25] Figure 6 is a partial longitudinal sectional view of a reciprocating compressor, for showing a coil spring in accordance with a second embodiment of the present invention;

[26] Figure 7A is a side view showing a coil spring in accordance with a second embodiment of the present invention;

[27] Figure 7B is a view showing a lateral displacement of a coil spring in accordance with a second embodiment of the present invention;

[28] Figure 8 is a partial longitudinal sectional view of a reciprocating compressor, for showing a coil spring in accordance with a third embodiment of the present invention;

[29] Figure 9A is a side view showing a coil spring in accordance with a third embodiment of the present invention; and

[30] Figure 9B is a view showing a lateral displacement of a coil spring in accordance with a third embodiment of the present invention.

Mode for Invention

[31] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

[32] Figure 3 is a longitudinal sectional view showing a reciprocating compressor in accordance with the present invention.

[33] As shown therein, the reciprocating compressor in accordance with the present

invention includes: a casing 100 forming an exterior of a compressor, having a certain space therein and including a suction pipe (SP) through which a refrigerant gas is introduced and a discharge pipe through which the refrigerant gas compressed in the compressor is discharged outside; a compressor main body 700 positioned in the casing 100, for compressing and discharging the sucked refrigerant gas; and a supporting unit 600 including a plurality of coil springs elastically connecting the compressor main body 700 to one surface of the casing 100 so that the main body 700 is fixed to the casing 100.

[34] The compressor main body 700 includes a frame unit 200 elastically connected to the supporting unit 600 and forming the whole frame of the main body 700; a reciprocating motor 300 fixedly installed at the frame unit 200, for generating a linear reciprocating driving force; and a compressing unit 400 supported by the frame unit 200, for compressing the sucked refrigerant gas by a driving force of the reciprocating motor 300.

[35] The frame unit 200 includes a front frame 210 having one surface supported by the supporting unit 600 and fixing one surface of the reciprocating motor 300; a middle frame 220 fixed to the other surface of the reciprocating motor 300 fixed at the front frame 210; and a rear frame 230 having one surface elastically fixed to the supporting unit 500 and connected to the middle frame 220.

[36] The reciprocating motor 300 includes an outer stator 310 fixedly installed between the front frame 210 and the middle frame 220 and having a winding coil 340 therein; an inner stator 320 facing the outer stator 310 at a certain interval and fixedly installed at one side of the front frame 210; and a rotor 330 linearly moving between the outer stator 310 and the inner stator 320.

[37] The compressing unit 400 includes a cylinder 410 inserted into the front frame 210 to be fixed thereto; a piston 420 having a path (F) for a refrigerant gas therein and having one end connected to the rotor 330 to thereby reciprocate in the cylinder 410; a suction valve 430 installed at a front end surface of the piston 420, for opening and closing the refrigerant gas path (F); and a discharge valve assembly 440 installed at one end surface of the cylinder 410, for controlling discharge of the compressor refrigerant gas. Accordingly, a compressing space (P) is formed between the suction valve 430 and the discharge valve assembly 440.

[38] Here, a front resonant spring 510 and a rear resonant spring 502 causing a resonant motion of the piston 420 are installed between one end of the piston 420 connected to the rotor 330 and one end of the front frame 210 and between the one end of the piston

420 and one end of the rear frame 230, respectively.

[39] A plurality of coil springs constituting the supporting unit 600 include, respectively, a front coil spring 610 connecting the front frame 210 to one surface of the casing 100; and a rear coil spring 620 connecting the rear frame 230 to one surface of the casing 100 so that the main body 700 is elastically fixed to the inside of the casing 100.

[40] As shown in Figure 3, the plurality of coil springs 610 and 620 are formed by being spirally wound several times, having the same diameter. That is, the coil spring 610, 620 has an inner coil 580 wound plural times and end coils 590 formed at both ends of the inner coil 580.

[41] The inner coil 580 has at least one part which is tightly wound so as to reduce vibration of the compressor main body 700, which is generated in a direction that the piston 420 moves. And, the end coil 590 is tightly wound so that the coil spring 610, 620 can be fixed to one surface of the compressor main body 700-the front frame 210 and the rear frame 230- and to one surface of the casing 100.

[42] There may be a plurality of embodiments of a reciprocating compressor having a supporting unit 600 including the plurality of coil springs 610 and 620. Hereinafter, the most preferred embodiments will now be described, and descriptions overlapping with the above description will be omitted.

[43] Figure 4 shows one of plural coil springs constituting a supporting unit of a reciprocating compressor in accordance with a first embodiment of the present invention.

[44] Even though only one front coil spring is depicted in figure 4, the same structure as that depicted in the drawing is applied to the rest of the coil spring of the reciprocating compressor. A structure depicted in another drawing for another embodiment to be described later is also applied to the rest of the coil spring of the corresponding compressor.

[45] The coil spring 610, 620 in accordance with the first embodiment of the present invention includes end coils 590 tightly wound so as to be respectively fixed to one surface of the casing 100 and one surface of the main body, particularly, one surface of the frame unit 200; and an inner coil 580 wound and connected to the end coil 590.

[46] The inner coil 580 includes a pair of elastic parts 631 having predetermined pitches (t) from the end coil 590 toward the central portion of the coil spring; and a mass part 632 formed at the central portion of the coil spring between the pair of elastic parts 631 and tightly wound without any interval.

[47] The winding number of the mass part 632 is twice ~ four times as many as that of

the end coil 590 so that the coil spring 610, 620 has a stiffness which can stand lateral vibration of a reciprocating motor 300 and a compressing unit 400.

[48] The pair of elastic parts 631 is wound having regular pitches.

[49] In addition, each of the elastic parts 631 may be wound at pitches (T) decreased as it goes from the end coil 590 toward the mass part 632 or may be wound at pitches (T) increased as it goes from the end coil 590 toward the mass part 632.

[50] In addition, each of elastic parts 631 may be wound at pitches increased and decreased alternately between the end part 590 and the mass part 632.

[51] The coil spring has longitudinal stiffness and simultaneously lateral stiffness by including the pair of elastic parts 631 and the mass part 632 between the pair of elastic parts 631.

[52] As shown in Figures 5A and 5B, as the mass part 632 which is wound tightly is formed between the pair of elastic parts 632, the lateral stiffness of the coil spring is increased, thereby attenuating a lateral displacement (L1) of the compressor main body 700 and so effectively reduce the vibration of the compressor main body.

[53] Figures 6 and 7 show a coil spring constituting a supporting unit of a reciprocating compressor in accordance with a second embodiment of the present invention.

[54] As shown in Figure 6, a coil spring 610, 620 in accordance with the second embodiment includes an end coil 590; and an inner coil 580 including a pair of mass parts 641 which are tightly wound right next to the end coil 590; an elastic part 642 wound at predetermined pitches (t) between the pair mass parts.

[55] The winding number of the mass part 641 preferably is two ~ four times as many as that of the end coil 590.

[56] The elastic part 642 is preferably wound at regular pitches (t).

[57] In addition, the elastic part 642 may be wound at pitches decreased as it goes toward the central portion of the coil spring 610, 620 or, contrary, at pitches (T) increased as it goes toward its central portion.

[58] In addition, the elastic part 642 may be wound at pitches increased and decreased alternately between the pair of the mass parts 641.

[59] As shown in Figures 7A and 7B, in this case, the lateral stiffness of the coil spring 610, 620 is increased by the mass parts 641 which are tightly wound, thereby effectively attenuating a lateral displacement (L2) generated by the vibration of the compressor main body 700.

[60] Figure 8 shows a coil spring constituting a supporting unit of a reciprocating compressor in accordance with a third embodiment of the present invention.

[61] As shown therein, a coil spring 610, 620 in accordance with the third embodiment includes an end coil 592; and an inner coil including a first elastic part 652 wound from an end coil 590 fixed at one surface of the compressor main body 700 at predeter mined pitches (t1), a second elastic part 653 wound from an end coil 590 fixed at one surface of the casing 100 at predetermined pitches (t2) that are different from those (t1) of the first elastic part 652, and a mass part 651 tightly wound between the first and second elastic parts 652 and 653.

[62] The pitches (t1) of the first elastic part 652 and the pitches (t2) of the second elastic part are regular, respectively, but the two pitches (t1 and t2) are different from each other.

[63] In addition, the first elastic part 652 and the second elastic part 653 may be wound at pitches (t1, t2) decreased as it goes from both end coils 592 and the mass part 651, and the decreasing ratios of the pitch (t1) and the pitch (t2) may be different from each other.

[64] On the contrary, the first elastic part 652 and the second elastic part 653 may be wound at pitches (t1 and t2) increased as it goes from both end coils 592 toward the mass part 651, and the increasing ratios of the pitch (t1) and the pitch (t2) may be different from each other.

[65] In addition, the first elastic part and the second elastic part 653 may be wound at pitches (t1 and t2) increased and decreased alternatively as it goes from both end coils 592 toward the mass part 651, and the increasing ratios of the pitch (t1) and the pitch (t2) may be different from each other.

[66] In addition, as other modifications, one of the first and second elastic parts 652 and 653 is wound at regular pitches, but the other elastic part may be wound at pitches increased as it goes toward the mass part 651. On the contrary, one of the first and second elastic parts 652 and 653 is wound at regular pitches, but the other elastic part may be wound at pitches decreased as it goes toward the mass part 651.

[67] In addition, one of the first and second elastic parts 652 and 653 is wound at regular pitches, but the other elastic part may be wound at pitches increased and decreased alternately as it goes toward the mass part 651.

[68] As shown in Figures 9A and 9b, by such a construction of a coil spring 610, 620 in accordance with the third embodiment, the lateral stiffness of the coil spring 610, 620 is increased by the mass part which is tightly wound. In addition, because elastic co-efficients of the first elastic part 652 and the second elastic part 653 are different from each other, a lateral displacement generated by the vibration of the compressor main

body 700 can be attenuated, more effectively.

[69] In addition, depending upon a design, the compressor main body may be supported at the casing by properly disposing coil springs constituting a supporting unit of the reciprocating compressor in accordance with each embodiment of the present invention.

[70] The reciprocating compressor in accordance with the present invention is operated as follows.

[71] When a current is applied to a winding coil 340 of an outer stator 310 of a reciprocating motor 300, an induction magnetic field having a direction changed by a direction of a current is formed at the outer stator 310, and an electromagnetic force having a direction changed by a direction of the induction magnetic field is generated between the outer stator 310 and the inner stator 320 by interaction between the induction magnetic field and a magnetic field of the inner stator 320. At this time, a rotor 330 and a piston 420 are moved together in a direction of the electromagnetic force, and simultaneously, the piston 420 linearly reciprocates in a cylinder by front and rear resonant springs 510, 520, thereby generating a pressure difference in a compressing space of the cylinder 410. Thus, a series of processes of sucking a refrigerant gas into the compressing space (P) and compressing the sucked refrigerant gas until the pressure reaches a certain level and then discharging the compressed refrigerant gas is repeatedly performed. Here, when the rotor 330 and the piston 420 of the reciprocating motor reciprocate, the compressor main body 700, a vibrating body is excessively shaken in a direction that the piston reciprocates, that is, in a lateral direction of the compressor, causing vibration. However, by the present invention, the coil spring 610, 620 for supporting the compressor main body 700 includes a mass part functioning as a kind of mass body by being tightly wound. In addition, an elastic part having predetermined pitches is formed near the mass part. Accordingly, the coil spring provides not only an elastic force which is a fundamental property as a coil spring but also high lateral stiffness, thereby attenuating a lateral displacement of the compressor main body and thus effectively reducing the vibration of the compressor.

[72] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

Industrial Applicability

[73] As discussed the above, in accordance with the present invention, a reciprocating

compressor having a supporting unit attenuating a lateral displacement can minimize lateral vibration of the compressor, which is generated in a direction that a reciprocating motor is operated when the reciprocating compressor is in operation.